

CLAIM AMENDMENTS

Please amend claims 1-3, 5-10, 12-16, 18, 20-22, and 24-27 as follows.

1. (Currently Amended) An apparatus, comprising:

a dual taper waveguide device disposed in a semiconductor layer, the dual taper waveguide device having:

a buried tapered waveguide section disposed in [a] the semiconductor layer; and

a tapered rib waveguide section disposed in the semiconductor layer ~~proximate to and having a common core with~~ the buried tapered waveguide section, the tapered rib waveguide section including a rib portion adjoining a slab portion, the slab portion of the tapered rib waveguide section adjoining the buried tapered waveguide section, the buried tapered waveguide section being beneath the slab portion of the tapered rib waveguide section, wherein an optical beam is directed into a larger end of the buried tapered waveguide section ~~and the tapered rib waveguide~~, the buried tapered waveguide section tapered to guide the optical beam therethrough into the slab portion of the rib waveguide section, ~~wherein a vertical height of the buried tapered waveguide at the larger end and at a smaller end opposite the larger end are substantially similar.~~

2. (Currently Amended) The apparatus of claim 1 further comprising an insulator disposed in the semiconductor layer, the insulator surrounding and serving as cladding for the buried tapered waveguide to provide vertical and lateral optical confinement in the buried tapered waveguide section.

3. (Currently Amended) The apparatus of claim 2 wherein the smaller end of the buried tapered waveguide section opposite the larger end of the buried tapered waveguide section is defined by the insulator disposed in the semiconductor layer.

4. (Original) The apparatus of claim 3 wherein the insulator comprises oxide grown in a tapered trench etched from the semiconductor layer.

5. (Currently Amended) The apparatus of claim 3 wherein the buried tapered waveguide section and the tapered rib waveguide section comprise epitaxial lateral overgrowth (ELO) silicon defined within the oxide.

6. (Currently Amended) The apparatus of claim 1 wherein the buried tapered waveguide section includes a first and second lateral taper regions, the first lateral taper region tapering at a first lateral taper rate from the larger end of the buried tapered waveguide section to the second lateral taper region of the buried tapered waveguide section, the second lateral taper region tapering at a second lateral taper rate from the first lateral taper region of the buried tapered waveguide section to the smaller end of the buried tapered waveguide section, wherein the first lateral taper rate is greater than the second lateral taper rate.

7. (Currently Amended) The apparatus of claim 1 wherein the tapered rib waveguide section includes a first and second lateral taper regions, the first lateral taper region tapering at a third taper rate from the larger end of the tapered rib waveguide section to the second lateral taper region of the tapered rib waveguide section, the second lateral taper region tapering at a fourth lateral taper rate from the first lateral taper region of the tapered rib waveguide section to the smaller end of the tapered rib waveguide section, wherein the third lateral taper rate is greater than the fourth lateral taper rate.

8. (Currently Amended) A method, comprising:

directing an optical beam into a larger end of a dual taper waveguide device disposed in a semiconductor layer, the dual taper waveguide device having a buried tapered waveguide section and a tapered rib waveguide section disposed in a semiconductor layer, the buried tapered waveguide section and a tapered rib waveguide section having a common core, the tapered rib waveguide section including a rib portion adjoining a slab portion, the slab portion of the tapered rib waveguide section adjoining the buried tapered waveguide section;

directing a mode of the optical beam propagating through the buried tapered waveguide section into the slab portion of the tapered rib waveguide section adjoining the buried tapered waveguide section, the buried tapered waveguide section being beneath the slab portion of the tapered rib waveguide section; and

outputting substantially all of the optical beam directed into the larger end of the buried tapered waveguide section and the tapered rib waveguide section from a smaller end of the tapered rib waveguide section, the smaller end of the tapered rib waveguide section opposite the larger end of the tapered rib waveguide section, ~~wherein a vertical height of the buried tapered waveguide at the larger end and at the smaller end are substantially similar.~~

9. (Currently Amended) The method of claim 8 further comprising shrinking a mode size of the optical beam from a larger mode size when directed into the larger end of the buried tapered waveguide and the tapered rib waveguide section to a smaller mode size when output from the smaller end of the tapered rib waveguide section.

10. (Currently Amended) The method of claim 9 wherein shrinking the mode size of the optical beam comprises:

shinking the mode size of the optical beam at a first lateral taper rate when the optical beam is directed into the larger end of the buried tapered waveguide section and the tapered rib waveguide section; and

shinking the mode size of the optical beam at a second lateral taper rate when directing the mode of the optical beam propagating through the buried tapered waveguide section into the slab portion of the tapered rib waveguide section adjoining the buried tapered waveguide section.

11. (Previously Presented) The method of claim 10 wherein the first lateral taper rate is greater than the second lateral taper rate.

12. (Currently Amended) The method of claim 8 wherein directing the optical beam into the larger end of the buried tapered waveguide section and the tapered rib waveguide section includes directing the optical beam from an optical fiber.

13. (Currently Amended) The method of claim 8 further comprising directing the optical beam from the smaller end of the tapered rib waveguide section into a semiconductor photonic device disposed in the semiconductor layer.

14. (Currently Amended) A method, comprising:
etching a first semiconductor layer of a silicon-on-insulator (SOI) wafer with a first mask;
etching a buried taper opening into a second semiconductor layer of the SOI wafer with a buried taper mask, the buried taper mask having a larger end and a smaller end, ~~wherein a vertical height of the buried tapered opening at the larger end and at the smaller end are substantially similar;~~
growing an insulating layer in the buried taper opening;
growing silicon in and over the buried taper opening over the insulator layer to form a buried tapered waveguide section of a dual taper waveguide device; and
patterning a tapered rib waveguide section of the dual taper waveguide device in the silicon grown over the buried tapered waveguide using a tapered rib waveguide mask such that a slab portion of the tapered rib waveguide ~~adjoins~~ shares a common core with the buried tapered waveguide, the buried tapered waveguide is beneath the slab portion of the tapered rib waveguide, the tapered rib waveguide having a larger end and a smaller end corresponding to the larger and smaller ends, respectively, of the buried tapered waveguide.

15. (Currently Amended) The method of claim 14 further comprising sharpening a tip of the buried tapered waveguide section defined at the smaller end of the buried taper opening by growing the insulating layer in the buried taper opening.

16. (Currently Amended) The method of claim 14 wherein etching the buried taper opening into the second semiconductor layer of the SOI wafer with the buried taper mask includes defining first and second lateral taper regions in the buried tapered waveguide section, the first lateral taper region of the buried tapered waveguide section to taper at a first lateral taper rate from the larger end of the buried tapered waveguide section to the second lateral taper region of the buried tapered waveguide section, the second lateral taper region of the buried tapered waveguide section to taper at a second lateral taper rate from the first lateral taper region of the buried tapered waveguide section to the smaller end of the buried tapered waveguide section.

17. (Previously Presented) The method of claim 16 wherein the first lateral taper rate is greater than the second lateral taper rate.

18. (Currently Amended) The method of claim 14 wherein patterning the tapered rib waveguide section in the silicon grown over the buried tapered waveguide section using the tapered rib waveguide section mask includes defining first and second lateral taper regions in the tapered rib waveguide section, the first lateral taper region of the tapered rib waveguide section to taper at a third lateral taper rate from the larger end of the tapered rib waveguide section to the second lateral taper region of the tapered rib waveguide section, the second lateral taper region of the tapered rib waveguide section to taper at a fourth lateral taper rate from the first lateral taper region of the tapered rib waveguide section to the smaller end of the tapered rib waveguide section.

19. (Previously Presented) The method of claim 18 wherein the third lateral taper rate greater than the fourth lateral taper rate.

20. (Currently Amended) The method of claim 14 further comprising optically coupling an optical fiber to the larger ends of the buried tapered waveguide section and the tapered rib waveguide section.

21. (Currently Amended) The method of claim 14 further comprising optically coupling a photonic device disposed in the SOI wafer to the smaller end of the tapered rib waveguide section.

22. (Currently Amended) A system, comprising:
an optical transmitter to transmit an optical beam;
an optical receiver; and
an optical device disposed between the optical transmitter and the optical receiver, the optical device including:

 a buried tapered waveguide section disposed in a semiconductor layer;
 a tapered rib waveguide section disposed in the semiconductor layer proximate to and having a common core with the buried tapered waveguide section, the tapered rib waveguide section including a rib portion adjoining a slab portion, the slab portion of the rib waveguide

section adjoining the buried tapered waveguide section, the buried tapered waveguide section being beneath the slab portion of the tapered rib waveguide section, wherein an optical beam is directed into a larger end of the buried tapered waveguide section and the tapered rib waveguide section, the buried tapered waveguide section tapered to guide the optical beam therethrough into the slab portion of the tapered rib waveguide section, ~~wherein a vertical height of the buried tapered waveguide at the larger end and at a smaller end opposite the larger end are substantially similar~~; and

 a photonic device disposed in the semiconductor layer optically coupled to the smaller end of the tapered rib waveguide section,

 the optical beam optically coupled to be received from the optical transmitter by the buried tapered waveguide section and the tapered rib waveguide, the optical beam to be directed from the tapered rib waveguide section through the photonic device to the optical receiver.

23. (Original) The system of claim 22 further comprising an optical fiber optically coupled between the optical transmitter and the buried tapered waveguide and the tapered rib waveguide.

24. (Currently Amended) The system of claim 22 wherein the optical device further comprises an insulator disposed in the semiconductor layer, the insulator surrounding and serving as cladding for the buried tapered waveguide section to provide vertical and lateral optical confinement in the buried tapered waveguide section.

25. (Currently Amended) The system of claim 24 wherein the smaller end of the buried tapered waveguide section opposite the larger end of the buried tapered waveguide section is defined by the insulator disposed in the semiconductor layer.

26. (Currently Amended) The system of claim 22 wherein the buried tapered waveguide section includes a first and second lateral taper regions, the first lateral taper region tapering at a first lateral taper rate from the larger end of the buried tapered waveguide section to the second lateral taper region of the buried tapered waveguide section, the second lateral taper region tapering at a second lateral taper rate from the first lateral taper region of the buried tapered

waveguide section to the smaller end of the buried tapered waveguide section, wherein the first lateral taper rate is greater than the second lateral taper rate.

27. (Currently Amended) The system of claim 22 wherein the tapered rib waveguide section includes a first and second lateral taper regions, the first lateral taper region tapering at a third lateral taper rate from the larger end of the tapered rib waveguide section to the second lateral taper region of the tapered rib waveguide section, the second lateral taper region tapering at a fourth lateral taper rate from the first lateral taper region of the tapered rib waveguide section to the smaller end of the tapered rib waveguide section, wherein the third lateral taper rate is greater than the fourth lateral taper rate.